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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
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09/434,736 11/02/99 KIM

S 000939-07360

020350 MMC2/0323
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EXAMINER

PERT. F

ART UNIT	PAPER NUMBER
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2813

DATE MAILED:

03/23/01

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary

Application No.

09/434,736

Applicant(s)

KIM ET AL.

Examiner

Evan T. Pert

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136 (a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 09 February 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-28,30-39,41-43,45-70,72-80 and 82-88 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-28,30-39,41-43,45-70,72-80 and 82-88 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claims _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 02 November 1999 is/are objected to by the Examiner.
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

- 15) ☒ Notice of References Cited (PTO-892)
- 16) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 17) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 18) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 19) ☐ Notice of Informal Patent Application (PTO-152)
- 20) ☐ Other: _____

DETAILED ACTION

Specification

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

The following is a quotation of 37 CFR 1.71(a)-(b):

(a) The specification must include a written description of the invention or discovery and of the manner and process of making and using the same, and is required to be in such full, clear, concise, and exact terms as to enable any person skilled in the art or science to which the invention or discovery appertains, or with which it is most nearly connected, to make and use the same.

(b) The specification must set forth the precise invention for which a patent is solicited, in such manner as to distinguish it from other inventions and from what is old. It must describe completely a specific embodiment of the process, machine, manufacture, composition of matter or improvement invented, and must explain the mode of operation or principle whenever applicable. The best mode contemplated by the inventor of carrying out his invention must be set forth.

The specification is objected to under 37 CFR 1.71 because it fails to disclose a method using a wet and/or dry etch to get the contact holes "having a tapered upper portion" that is exemplified only by applicant's figures, but is required by the claims. Presumably, the figures do not accurately show the claimed "tapered upper portion" since a known wet etch followed by a dry etch would actually result in a tapered shape as shown in the cover Figure to Park as "stepped portion 1". As another example of lack of enablement in forming the only example of "tapered upper portion" set forth by applicant in the disclosure, the examiner cites a patent issued to Sato, who teaches the very contact hole profile depicted by applicant, but Sato teaches forming it by first filling the via partway [e.g. Fig. 6D].

The specification is also objected to under 37 CFR 1.71 because it fails to disclose how "selective tungsten" is formed "in one single step" or in "a continuous step" as in claims 5 and 10.

Claim Rejections - 35 USC § 112

2. Claims 1-28,30-39,41-43,45-70,72-80 and 82-88 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Regarding the limitations of contact hole profiles having a "tapered upper portion", applicable to all the claims, applicant only shows the exemplary profile, but does not explain how to form it, or anything else about it for that matter. Applicant's only reference to the so-called "taper" is at col. 3, lines 38-42 of the patent, where it states that "the selective films are overgrown appropriately to prevent misalignment with a second contact hole to be formed above the first contact hole"; this characterization contradicts the known resultant "overgrown" structure of a selectively deposited tungsten plug having a so-called "nail-head" shown as (6) in Prior Art Figure 1B of the patent issued to Flanner. How does one of ordinary skill in the art form the contact hole profile depicted as "having a tapered upper portion" in applicant's figures where the sloped walls are straight, not curved?

Regarding claims 5 and 10, applicant argues that the prior art does not teach "one single step" or "a continuous step" in filling the contact holes (selectively) since the prior art teaches sub-steps such as forming a seed layer or changing deposition gas.

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Yet, in the same breath, applicant fails to teach "how" the "one step" deposit is made in "one step", argued as novel (in paper no. 11). Applicant even argues that "of no surprise, Gutierrez fails to disclose, teach or suggest a single step process for filling vias on a single layer" [page 25 of response filed 2-9-01 (paper no. 11)]. If it is indeed "no surprise" that it takes more than one step in the prior art, then applicant is obligated to disclose such a novel method that selective deposition can occur "in one single step". Nothing in applicant's disclosure explains how this "one single step" occurs, rendering claims 5 and 10, as well as the claims depending therefrom, non-enabled.

Drawings

3. The drawings are objected to under 37 CFR 1.83(a) because they fail to show the contact hole profile "having tapered upper portions" known in the art. Any structural detail that is essential for a proper understanding of the disclosed invention should be shown in the drawing. The profile should seemingly look like that of the cover figure to Park having clearly first isotropically wet-etched a concave followed by an anisotropic straight-walled dry etch. MPEP § 608.02(d). Correction is required.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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5. Claims 11-28,30-39,41-43,45-70,72-80 and 82-88 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gutierrez in view of the combination of Kim et al., Fink & Christiansen, Sery et al., Park, and Wolf.

Wolf is relied on as a teaching reference for teaching two types of well known CVD processes to fill contact holes with metal: "blanket CVD and (etchback)" and "selective CVD" [Wolf; section 4.5.4, starting on page 245].

Fink and Christiansen are cited for teaching why it is advantageous for contact holes to have sloped (tapered) sidewalls for better step coverage, for example in a blanket CVD process [second to last sentence on page 8-18]. Sloped sidewalls have "a tapered upper portion" and also a wider top than bottom, as claimed by applicant. One of ordinary skill in the art would be motivated to use sloped (i.e. "having a tapered upper portion") contact hole profile if blanket CVD were the chosen deposition method to get better step coverage as is apparent at M1 in Kim et al..

Sery et al. is only cited to show that Gutierrez indeed shows a gate stack structure on the first layer which is a "first region", a "gate", a "gate stack", a "gate with underlying oxide" as claimed by applicant. The layer of polysilicon in the cover figure of Gutierrez that connects to via 228 is a gate which can be seen by related teachings of figures 3E and 3F of Sery et al..

It would be readily apparent to one of ordinary skill in the art that Gutierrez is silent with respect to the gate and contact to the gate. Thus, the examiner relies on Sery et al. only to show the "opening holes to the gate" limitations are inherently expected as part of the teachings Gutierrez. The field oxide (under 228), the junction

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layer (under 226), and conductive pattern on the first insulating layer 220 are readily understood.

Like applicant, Gutierrez shows a "two-step" deposition being step 1 to get plug 226 and step 2 to get 224. Gutierrez teaches that the first and second insulating layers may be conformal or planar [col. 5, lines 25-41].

Kim et al. also shows a "two-step" deposition of first M1, then tungsten plugs, in their cover figure. Kim et al. show a conformal uniform thickness first dielectric, and a planar second dielectric with their invention specifically addressing the use of an etch-stop to cope with the unequal depths of the contact holes in the second insulating layer. Kim et al. teach the difficulties of alignment of the upper and lower holes and the use of "frames" seen as M1 extending above and outward to give a greater target area for the tungsten hole plug above it [col. 1, lines 11-55].

In view of Kim et al., it would be advantageous to use the invention of Gutierrez, instead making the second insulating layer of uniform thickness. Thus, the whole etch stop could be eliminated from Kim et al. by following second layer procedures of Gutierrez.

Park is cited for teaching a known structure having a "nail-head" shape useful like a frame taught by Kim et al., but more advantageous being planar (i.e. plug 4a). The structure would be readily apparent to one of ordinary skill in the art as being formed by a wet (isotropic) etch followed by dry (anisotropic) etch. Since this plug has a planar upper surface and has a landing area bigger than the via, one of ordinary skill in the art

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would be motivated to practice such shaping to ease alignment as is taught by Gutierrez [col. 3, lines 44-50] and Kim et al. [col. 1, lines 27-28].

Regarding dependent claim limitations not addressed above:

Fink and Christensen teach well known oxide as a preferred ILD.

Park teaches the well known fact that polysilicon and tungsten were useful as contact hole fill materials prior to applicant's filing [col. 1, line 66 to col. 2, line 8]. One of ordinary skill in the art would thus be motivated to use polysilicon as an alternative to tungsten as a mere design choice.

Kim et al. teach the well known use of "photoresist" to form holes [e.g. at col. 3, lines 36-38].

Kim et al. teach the well known fact that contact junctions can be either "N+" or "P+" (as in the cover figure).

6. Claims 1-10 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gutierrez in view of the combination of Kim et al., Fink & Christiansen, Sery et al., Park, and Wolf as applied to the independent claims above, and further in view of Flanner.

Flanner is cited to address the limitation of claims 1-10 that selective layers are "grown over and extend slightly beyond " the holes. While such is implied by Kim et al. since the M1 plugs in their cover figure have "nail-heads", Flanner adds the teaching that an overgrown selective deposit in a via looks like a nail-head having a larger area than the via itself. Seeing the nail-head shape, one of ordinary skill in the art would be motivated to use this top of the via as a frame to ease alignment problems as is taught Gutierrez [col. 3, lines 44-50] and Kim et al. [col. 1, lines 27-28]. Since all the openings

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are the same depth in Gutierrez, in view of Wolf they would all overflow at the same time during a selective deposit to form nail-heads shown by Flanner, thus providing a wider "frame" to land.

One of ordinary skill in the art, then, would be motivated to overgrow "slightly" to get the shape taught by Flanner, rather than stopping "when the recesses are filled" as taught by Gutierrez at col. 4, lines 40-44, all to address alignment.

Response to Arguments

7. Applicant's arguments with respect to claims 1-88 have been considered but are moot in view of the new ground(s) of rejection.

8. In view of applicant's amendment, the objection to claims 17, 32, and 41 (based on impermissible recapture) is withdrawn.

9. Applicant argues "Gutierrez does not even recognize the problem of misalignment" [bottom page 24]. The examiner respectfully disagrees, referring applicant to lines 48-50 of col. 3 of Gutierrez. Gutierrez even suggests that the overlying contact hole (i.e. via) should be narrower than the pad of material at the bottom of the via (a so-called "seed material") to address misalignment problems.

10. Applicant argues Gutierrez teaches a method of forming "a semiconductor-insulator layer with a planar surface", not conformal even-thickness layers [bottom paragraph of page 24 of applicant's response]. However, applicant's cited portion of Gutierrez is background art that required planar surfaces. Gutierrez teaches an invention applicable to planar or substantially uniform conformal layers [see col. 5, lines 25-41, particularly lines 34-41].

11. Applicant argues that Gutierrez does not teach applicant's "one step" in selectively depositing to fill the vias. The examiner respectfully disagrees since Gutierrez only requires "one step" (i.e. no seeding step) when tungsten is used, since a "seed layer" does not always need to be formed; For example, via 226 can be "formed directly onto the silicon substrate using the substrate as a seed" [col. 5, lines 23-24] or onto another tungsten via as is notable in the cover figure.

Wolf also teaches selective deposition of tungsten into vias with a silicon bottom, but there are substeps involved [see Section 4.5.4.3 starting at page 251]. As set forth above in this Office Action, applicant has not enabled a "single step" in filling vias since applicant characterizes known methods such as taught by Wolf and Gutierrez as involving more than "one step". How does one of ordinary skill in the art practice this "one step" selective deposition method by applicant?

12. While the Hashimoto reference is now moot, the examiner would like to point out applicant's mischaracterization of blanket deposition and etchback [at page 27 of applicant's response]. The "blanket" is known to cover the entire surface of the substrate, while the "etchback" removes the temporary "shorts" across the insulating layer in which the holes are formed. This is in contrast to "selective deposition" in which the tungsten only grows in the holes, selectively [see Wolf, Section 4.5.4 starting at page 245].

13. Applicant has objected to the examiner taking Official Notice. This objection is moot as the limitations of all claims have been addressed with respect to teachings of cited prior art.

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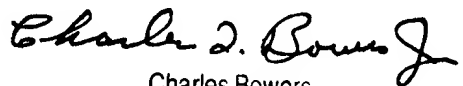
Conclusion

14. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Evan T. Pert whose telephone number is 703-306-5689. The examiner can normally be reached on M-F (7:00-3:30).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Charles Bowers can be reached on 703-308-2417. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7722 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

ETP
March 22, 2001



Charles Bowers
Supervisor Patent Examiner
Technology Center 2800